

waters receiving groundwater discharge from the site (discussed further in Section 2.3).

2.1.4 Comparison With Appropriate Criteria

Since there were no receptors of shallow groundwater identified, a comparison with appropriate exposure limit criteria is not relevant.

2.1.5 Assessment of Potential for Exposure

The investigation for the site has indicated that only localized groundwater in the shallow water-bearing zone may be potentially impacted by activities at the RMI Sodium Plant. Only Ba and Cd were identified as being present in elevated concentrations over background in the shallow groundwater zone. Although there is the potential for shallow groundwater to migrate off site, this migration is believed to be limited to areas north and possibly to the south of the site. In addition, the shallow groundwater is expected to move very slowly, due to the low permeability of the glacial till. In addition, no receptors of shallow groundwater in the vicinity of the site were identified. Therefore, the groundwater exposure pathway is incomplete--no potential for exposure to site constituents via groundwater is predicted.

2.2 SOIL PATHWAY

2.2.1 Potential Sources and Concentrations

As discussed in Section 4.3 of the Revised RFI report, the predominant soil type in the vicinity of the RMI Sodium Plant is a silt loam, generally characterized as level and poorly drained. Because of the development of the Sodium Plant and the various land use activities on site, however, the original soils in the immediate plant area have been greatly altered. Inspection of the boring logs generated from on-site drilling indicates that approximately 44 to 59 feet of unconsolidated deposits (glacial till, fill, and/or clay cap) overlies Devonian Chagrin Shale bedrock. The glacial till is subdivided into weathered and unweathered zones, and is overlain by up to 7 feet of manmade fill throughout the site. In the area of the closed landfill, 3.5 feet of clay overlies the till and comprises the landfill cap.

There are six distinct fill areas located throughout the site (Areas A, B, C, D, F, and G). Each of these areas received several types of inorganic plant wastes at different times during the plant's history (see Section 5.2 of the Revised RFI report). Barium, Cd, and Pb are the major waste constituents expected in the fill areas, based on disposal history (see Table 5-3 of the Revised RFI report). Some of the fill areas were used for subsurface disposal, and other areas are believed to contain more superficial deposits of plant wastes, i.e., they are more characteristic of waste pile activities than of conventional landfilling.

Both surficial (0 to 4 inches) and subsurface soils (ranging from 0.5 to 58 feet) were sampled in areas throughout the site as a part of this investigation. Extensive background surficial soil sampling was performed at the plant to provide enough data for a statistical comparison of site surficial soil concentrations to be performed. The statistical analysis of surficial soil data is presented in Section 6.2.1 of the Revised RFI report. The results of this analysis were used to identify particular site constituents and areas of concern in surficial soils relative to background concentrations. As summarized in Section 6.2.1 and in Table 6-3 of the Revised RFI report, the following areas and constituents were shown to have significant (at the 0.05 level of confidence) concentrations over background:

- Closed Landfill (Area A) --None
- Fill Area Northeast of the Closed Landfill (Area B) --Ba, Cd, Pb, Ni, As
- Fill Area Northwest of the Closed Landfill (Area C) --Ba, As, Se
- Wastewater Treatment Ponds and Fill Areas in Vicinity (Areas D and E) --
No surficial soils analyzed
- Fill Area West of the Wastewater Treatment Ponds (Area F) --Ba, Cd, Pb,
As, Ni
- Fill Area North of the Wastewater Treatment Ponds (Area G) --Ba, Cd, Cr,
Ni, As

Subsurface soils were investigated by borings, some of which were later developed into monitoring wells (see Section 6.2.2 of the Revised RFI report). In order to evaluate site areas which appear to have only surficial presence of site constituents and those which indicate deeper levels of constituents, the surficial and subsurface soil data were averaged and arranged together, by SWMUs, in a series of tables (see Tables 6-2 and 6-5 of the Revised RFI report). Tables 2-2, 2-3, 2-4, 2-5, 2-6, and 2-7 show average surficial and subsurface soil concentrations for Background; Area A; Areas B and C; Area D (subsurface only); Area F; and Area G, respectively.

2.2.1.1 Surficial Soil Concentrations. As shown in Tables 2-2 through 2-7, the highest average surficial soil concentrations for all measured inorganic constituents were found for the fill areas northwest and northeast of the closed landfill (Areas B and C, combined), with the exception of Cr (highest in Area F, west of wastewater ponds) and Se (highest in Area G, north of the wastewater ponds). However, Cr concentrations in Area F and Se concentrations in Area G were not found to be significant over background levels. Silver was BMDL in all surficial soil samples. The highest average surficial soil concentrations significant over background in either Area B and C ranged in the following order: Ba (1,084 ppm) ; Ni (280.7 ppm); Pb (218.1 ppm); Cd (103.5 ppm); Cr (20.4 ppm); As (20.1 ppm); and Se (0.64 ppm). Barium concentrations measured in surficial soils from Areas B and C (combined) were considerably higher than Ni, Pb, and Cd concentrations. Although Se in Area C was found to be significant over background, the average Se concentration of Area B and C combined is not expected to be significant.

Average surficial background concentrations for the constituents of concern ranged in the following order: Ba (97.4 ppm); Ni (26.1 ppm); Pb (24.9 ppm); Cr (14.0 ppm) ; As (12.0 ppm) ; Cd (4.75 ppm); and Se (0.51 ppm). Concentrations of Ba, Cr, As, Ni, and Pb were detected most frequently (greater than or equal to 9 out of 12 samples) in background samples.

Although some site constituents in Areas B or C were determined to be significant over background, a closer examination of the statistics indicates that several of the constituents probably do not present a concern, relative to other constituents present (see Table 6-3 of the Revised RFI report). For example, Se (in Area C) should probably not be considered because the background variance is very low due to the assumption that BMDL concentrations equal the detection limit, and only 2

TABLE 2-2
AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
BACKGROUND

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
Detection Limits	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(Borings - 1.0; Surficial - 5.0)	(0.5)
Surficial (0 to 4 in.)	SSB1 - SSB12	97.4	4.75	24.9	14.0	26.1	BMDL	0.20	12.0	0.51
1.0 - 5.0	9S, 9D, 10S, 11D	67.2	BMDL	29.9	15.9	14.5	BMDL	BMDL	22.8	0.66
9.7 - 10.9	9S, 10S, 11D	98.8	BMDL	BMDL	19.0	22.1	BMDL	BMDL	16.5	BMDL
14.5 - 19.5	9D, 10S	73.2	BMDL	BMDL	18.2	21.0	BMDL	BMDL	18.7	BMDL
56.5 - 57.0	9D	BMDL	BMDL	BMDL	20.6	29.3	BMDL	BMDL	16.4	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).
NA=Not Applicable

TABLE 2-3
AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
AREA A – CLOSED LANDFILL

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
(Detection Limits)	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(Borings - 1.0; Surficial - 5.0)	(0.5)
Surficial (0 to 4 in.)	SS1-1, SS1-2, SS1-3, SS1-4	75.4	BMDL	15.1	14.8	22.6	BMDL	BMDL	14.6	BMDL
3.5 - 6.0	1S, 2S, 3S, 4D	67.5	BMDL	16.0	14.6	14.9	BMDL	BMDL	14.5	BMDL
9.5 - 17.0	1S, 2S, 3S	60.5	3.95	15.5	15.8	17.1	BMDL	0.24	14.9	BMDL
21.0 - 24.5	1S, 2S, 4D	52.1	BMDL	15.6	15.1	19.8	BMDL	BMDL	13.7	BMDL
46.2 - 46.7	4D	54.0	BMDL	BMDL	19.7	25.9	BMDL	BMDL	19.1	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).
NA-Not Applicable

TABLE 2-4
AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
AREAS B AND C – AREAS NORTHWEST AND NORTHEAST OF CLOSED LANDFILL

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
(Detection Limits)	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(Borings - 1.0; Surficial - 5.0)	(0.5)
Surficial (0 to 4 in.)	SS2-1, SS2-2, SS2-3, SS2-4, SS3-1, SS3-2, SS3-3, SS3-4	1,084	103.5	218.1	20.4	280.7	BMDL	0.4	20.1	0.64
0.8 - 3.0	SB-11, SB-12, SB-13	92.5	BMDL	15.6	9.6	7.5	BMDL	BMDL	20.8	0.75
7.5 - 11.5	SB-11, SB-12, SB-13	47.9	BMDL	15.6	14.3	14.2	BMDL	BMDL	19.4	BMDL
28.0 - 29.5	SB-11, SB-12, SB-13	39.2	BMDL	15.6	13.5	14.2	BMDL	BMDL	15.6	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).

NA=Not Applicable

TABLE 2-5

AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
 AREA D – FILL AREA IN VICINITY OF WASTEWATER PONDS

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
(Detection Limits)	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(1.0)	(0.5)
Surficial		None Collected in Area								
3.0 - 6.5	5D, 6S	524.8	BMDL	37.4	18.7	87.21	BMDL	BMDL	20.8	BMDL
13.3	6S	72.1	BMDL	BMDL	17.6	19.3	BMDL	BMDL	20.4	BMDL
56.5 - 57.0	5D	36.0	BMDL	BMDL	19.7	25.9	BMDL	BMDL	20.8	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).

NA=Not Applicable

TABLE 2-6

AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
 AREA F – FILL AREAS WEST OF WASTEWATER PONDS

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
(Detection Limits)	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(Borings - 1.0; Surficial - 5.0)	(0.5)
Surficial (0 to 4 in.)	SS4-1, SS4-2, SS4-3, SS4-4	317.8	3.1	87.5	20.5	60.7	BMDL	0.25	17.6	BMDL
0.5 - 1.7	7D, SB-14, SB-15	40.5	1.10	BMDL	10.1	11.3	BMDL	BMDL	17.7	0.86
8.5 - 14.5	7D, SB-14, SB-15	48.9	BMDL	15.4	15.7	19.2	BMDL	BMDL	15.5	BMDL
29.5 - 30.0	SB-14, SB-15	26.0	BMDL	BMDL	15.0	18.5	BMDL	0.25	20.0	BMDL
57.6 - 58.1	7D	BMDL	BMDL	BMDL	20.6	27.6	BMDL	BMDL	22.7	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).

NA=Not Applicable

TABLE 2-7

AVERAGE SURFICIAL AND SUBSURFACE SOIL CONCENTRATIONS^a
AREA G – FILL AREAS NORTH OF WASTEWATER PONDS

Sample Depth Range (ft)	Sample Nos. in Average	Average Concentration (mg/kg)								
		Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
(Detection Limits)	NA	(25.0)	(1.0)	(15.0)	(2.5)	(5.0)	(1.5)	(0.2)	(Borings - 1.0; Surficial - 5.0)	(0.5)
Surficial (0 to 4 in.)	SS5-1, SS5-2, SS5-3, SS5-4	119.5	8.07	29.1	18.6	29.9	BMDL	0.28	18.5	0.73
0.5 - 3.3	8S, SB-16, SB-17	1,396 ^b	85.2 ^b	189.9 ^b	35.2 ^b	156.6 ^b	3.4 ^b	0.51 ^b	17.2	BMDL
6.5	8S	72.1	BMDL	BMDL	16.7	22.6	BMDL	BMDL	18.9	BMDL
17.3 - 18.0	SB-17	162.0	3.10	21.1	11.9	11.3	BMDL	BMDL	20.1	BMDL
29.5 - 30.0	SB-16, SB-17	63.1	BMDL	BMDL	16.3	20.9	BMDL	BMDL	16.3	BMDL

^aFor averaging purposes, concentrations at BMDL were assumed to be equal to the detection limit, except where all measurements were BMDL (see Section 6.2 of the Revised RFI report).

^bHighest average subsurface soil concentrations measured on site, for all areas.

NA=Not Applicable

of 12 background samples had detectable levels of Se. Also, Cd (in Area B) should be viewed as an exception because one sample in the average (SS3-3 at 731 ppm) greatly affects the mean, resulting in an extremely high variance; therefore, the presence of elevated levels of Cd is probably highly localized in Area B. Therefore, the surficial soils of potential concern in Areas B and C reduce to Ba, Cd, Pb, Ni, and As.

Average surficial soil concentrations in Areas F or G (fill areas west and north of the wastewater ponds, respectively) were found to be significant over background for the following constituents: Ba, Cd, Pb, Cr, Ni, and As. The highest concentrations of these constituents in Areas F and G ranged accordingly: Ba (317.8 ppm, in F); Pb (87.5 ppm, in F); Ni (60.7 ppm, in F); Cr (20.5 ppm, in F); As (18.5 ppm, in G); and Cd (8.1 ppm, in G). Again, although determined to be significant over background, Cr (Area G), and Cd (Area F) should probably not be considered because of high background variances compared to sample variances (see Table 6-3 of the Revised RFI report). Therefore, the surficial soils of potential concern in Areas F and G reduce to Ba; Cd (Area G only); Pb (Area F only); Ni; and As. As noted in Section 5-2 of the Revised RFI report, Ba, Cd and Pb are known constituents of the waste materials placed in the fill areas.

2.2.1.2 Subsurface Soil Concentrations. Examination of the subsurface soil data (see Tables 2-2 through 2-7) for Areas A, B and C, F, and G generally indicate that concentrations of site constituents greatly decrease with depth, as further discussed below.

In Area A, the closed landfill, no constituents of concern were identified in surficial soils. This is to be expected, as the landfill is capped with 3.5 feet of clay from off site. Subsurface soil concentrations in Area A were averaged over 3.5 to 6.0 feet; 9.5 to 17.0 feet; 21.0 to 24.5 feet, and 46.2 to 46.7 feet (see Table 2-3). The highest concentrations of constituents in subsurface soils in Area A were found at various depths (see Table 2-3). However, in all cases the highest concentrations were very similar to surficial levels and indistinguishable from background concentrations (see Table 2-2) for similar depths. Therefore, neither average surficial soil or average subsurface soil concentrations up to 46.7 feet appear to be present in levels of concern in Area A.

In Areas B and C, the fill areas northwest and northeast of the closed landfill, subsurface soil concentrations were averaged over the following depths: 0.8 to 3.0 feet; 7.5 to 11.5 feet; and 28.0 to 29.5 feet. Average surficial soil concentrations of all constituents (except Se) were higher than any subsurface soil concentration average (see Table 2-4). The average surficial soil concentration for Se was 0.64 ppm, and the only detectable subsurface soil average concentration was 0.75 ppm, at 0.8 to 3.0 feet. However, because Se in surficial soils is not considered to be of significance in Area C, the subsurface average concentration of 0.75 ppm is probably also insignificant. Average soil concentrations, comparing the surficial layers (0 to 4 inches) to the first subsurface layer (0.8 to 3.0 feet), for all other parameters appears to diminish greatly for all constituents except As, which has fairly consistent concentrations from surficial layers to 29.5 feet in Areas B and C. Therefore, although elevated levels of Ba, Cd, Pb, Ni and As are indicated in the surficial soils of Areas B and C, presence of these constituents appears to be limited to the upper 3.0 feet (or less) of soil in these areas.

The fact that elevated levels of most constituents are not evident in subsurface soils in Areas B and C indicates that contamination is limited to surficial soils, which is consistent with what is known about the placement of wastes in these areas; and/or surficial soils are effectively attenuating constituents from vertical migration through the soil profile (discussed further in Section 2.2.2).

In Area D, the fill area in the vicinity of the wastewater treatment ponds, no surficial soil samples were collected. Subsurface soil concentrations were averaged over the following depths: 3.0 to 6.5 feet; 13.3 feet; and 56.5 to 57.0 feet (see Table 2-5). Average subsurface soil concentrations were highest in the first layer (3.0 to 6.5 feet) for Ba, Pb, and Ni, but tended to decrease greatly with depth for these constituents. At a depth of 13.3 feet, Ba, Pb and Ni each decreased to levels comparable to background levels measured at a similar depth (see Table 2-2). Average subsurface soil concentrations appeared not to vary noticeably with depth for Cr and As, and were similar to background concentrations at similar depths. Arsenic was found in consistent concentrations at all depths measured. Concentrations for Cd, Ag, Hg, and Se were BMDL for all depths measured. Therefore, although conclusions cannot be made concerning surficial soils, only Ba, Pb, and Ni appear to be present in subsurface soils in elevated concentrations up to depths between 6.5 and 13.3 feet. This finding is consistent with known waste

practices in Area D, i.e., it was once a topographically low fill area. However, the absence of Cd in subsurface soils is somewhat surprising since it is a principal waste constituent at the site.

In Area F, the fill area west of the wastewater ponds, elevated levels of surficial soils were indicated for Ba, Pb, Ni, and As, as previously discussed. Subsurface soil concentrations were averaged over the following depths: 0.5 to 1.7 feet; 8.5 to 14.5 feet; 29.5 to 30 feet; and 57.6 to 58.1 feet. Concentrations of subsurface soil constituents generally appear to greatly decrease with depth in samples collected from the surficial layer (0 to 4 inches) compared to samples collected from the 0.5 to 1.7 foot depth, with the exception of Cd, As, and Se, which are not distinguishable from surficial concentrations (see Table 2-6). Arsenic was found in consistent concentrations at all depths measured. Silver was BMDL in all samples, and Hg was only detected at one subsurface level, in trace concentrations. Although a true "gradient" of concentrations is not consistently noted in Area F subsurface soils for all constituents, none of the concentrations of subsurface soils collected at depths greater than 1.7 feet appear to be distinguishable from background levels at similar depths. Therefore, although elevated levels of Ba, Pb, Ni, and As have been indicated in the surficial soils of Area F, it appears that the elevated soil concentrations are limited to the upper 4 inches, and that surficial soils are effectively attenuating constituents from the vertical migration through the soil profile in Area F.

Area G, the fill area north of the wastewater ponds, was also once a topographically low area used for landfilling activities, similar to Area D. As previously discussed, elevated surficial soils in this area were indicated for Ba, Cd, Ni, and As. Subsurface soil concentrations were averaged over the following depths: 0.5 to 3.3 feet; 6.5 feet; 17.3 to 18.0 feet; and 29.5 to 30 feet. Average concentrations of subsurface soils in Area G do not exhibit the same pattern of distribution as the other areas previously discussed, i.e., there is no distinct decrease in average concentrations of site constituents with increasing depth (see Table 2-7). In fact, higher concentrations of all constituents, except Se and As, exist at the 0.5 to 3.3 feet depth compared to the upper, surficial (0 to 4 inches) layer of soil. In addition, the highest average concentrations of all subsurface soils measured in all areas were found in the 0.5 to 3.3 feet zone for all constituents except As and Se: Ba (1,396 ppm), Cd (85.2 ppm), Pb (189.9 ppm), Cr (35.2 ppm), Ni (156.6 ppm), Hg

(0.51 ppm), and Ag (3.40 ppm). Selenium was BMDL in all subsurface samples, and As was found in consistent concentrations at all depths. Average subsurface soil concentrations for Ba, Cd, and Pb each decrease at 6.5 feet, and then increase again at the 17.3 to 18.0 foot range, but at concentrations lower than the 0.5 to 3.3 foot measurements. Average concentrations at the 17.3 to 18.0 foot range for Ba, Cd, and Pb appear to be present in elevated levels compared to background for those constituents at a similar depth. Figure 2-2 shows this trend for soils in Area G for Ba, Cd, Pb, Ni, As and Ag. Because of this pattern of constituent distribution, it appears that higher concentrations at lower depths in Area G are indicative of waste placement, rather than of downward leaching. If downward leaching of constituents in the upper soil layers was occurring via incident precipitation, more of a gradient of contamination from upper to lower layers of soil would be expected. The pattern of constituent distribution shown in Figure 2-2 for Area G seems to indicate that wastes of different concentrations were placed at different depths in this area over time.

In summary, the soil data indicate that the following constituents are present in elevated concentrations for the following SWMUs:

- Closed Landfill (Area A)

Surficial (0 to 4 inches) -- None

Subsurface -- None, from surface to approximately 47 feet

- Fill Areas Northwest and Northeast of Landfill (Areas B and C)

Surficial (0 to 4 in.) -- Ba, Cd, Pb, Ni, and As

Subsurface -- None, up to approximately 29.5 feet

- Fill Area in Vicinity of Wastewater Ponds (Area D)

Surficial -- No samples collected in area (unknown)

Subsurface -- Ba, Ni and Pb, up to a depth between 6.5 and 13.3 feet

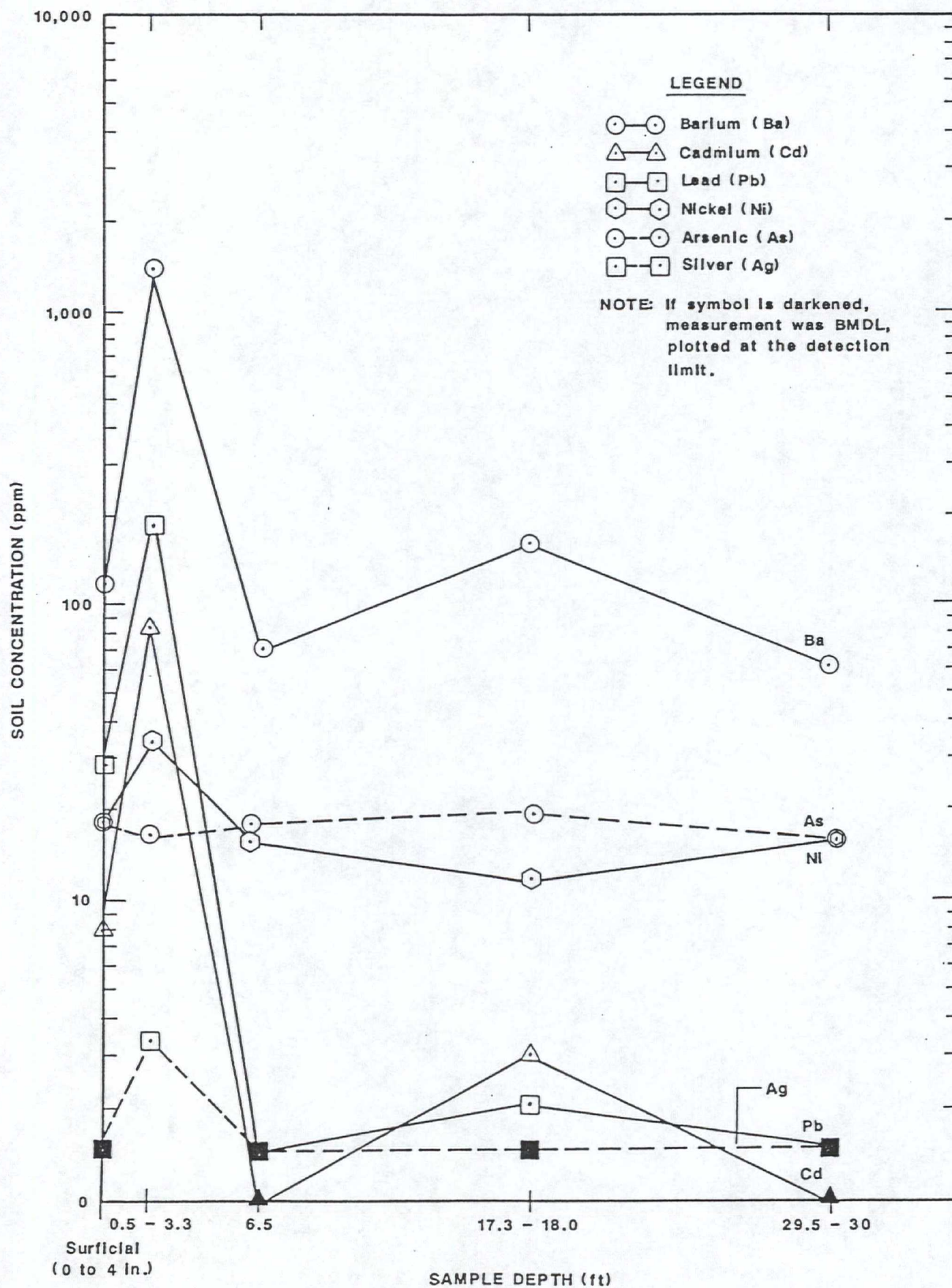


FIGURE 2-2 CONCENTRATION OF CONSTITUENTS IN SOILS WITH INCREASING DEPTH IN AREA G

- Fill Area West of Wastewater Ponds (Area F)

Surficial (0 to 4 inches) -- Ba, Pb, Ni, As

Subsurface -- None, from surface to approximately 58 feet

- Fill Area North of Wastewater Ponds (Area G)

Surficial (0 to 4 inches) -- Ba, Cd, Ni, As

Subsurface -- Ba, Cd, Pb, Cr, Ni, Ag, and Hg at 0.5 to 3.3 feet; Ba, Cd and Pb at 17.3 to 18.0 feet

The fact that Ba, Cd, and Pb are known to be principal waste constituents placed in the fill areas over time is generally confirmed by the levels and frequencies of detection of these constituents in the surficial and subsurface soils collected. The presence of other inorganic constituents in soils such as Ni, Cr, Ag, Hg, and Se may be due to the corrosion of process equipment, the concentrations of these constituents in the brine used in the processes, or concentrations present in raw water obtained from Lake Erie.

The detection of As at remarkably consistent concentrations in surficial and subsurface soils (from approximately 10 to 24 ppm) in the fill areas as well as background locations suggests that these levels of As are natural to this area of Ashtabula County. Because much of the RMI Sodium Plant site contains fill imported from off site (presumably from neighboring agricultural areas), it is likely that As concentrations in the fill represent natural geologic processes, or possibly residuals from the agricultural use of arsenic-containing pesticides.

2.2.2 Potential for Release and Migration

The only expected potential migration pathways of site constituents in soils to other media are: potential leaching (dissolution) from soils to shallow groundwater and/or to surface water; and potential erosion of surficial soils to air and/or on-site surface

water drainage ditches. The potential for release of site constituents via these pathways is discussed below.

2.2.2.1 Physical Properties Affecting Release and Migration. The behavior of inorganic constituents in soil and potential subsequent transfer to groundwater and surface water is dynamic and complex. Properties of the constituent, the soil, and other various physical and environmental phenomena have been demonstrated to have an effect on the mobility (or conversely, the attenuation or sorption potential) of various inorganics. Table 2-8 lists some of the factors which might be expected to influence the attenuation or sorption potential of inorganics in soil. Although a great number of factors can influence the mobility of inorganics in soil, there are general trends which can be identified. Some of the factors which are expected to exhibit the greatest influence on the sorption potential of the inorganic constituents found in soils at the RMI Sodium Plant will be discussed in this section, relative to the site constituents' potential to migrate off site.

Although elevated concentrations of various inorganic constituents have been identified in surficial and subsurface soils at the RMI Sodium Plant, site conditions are believed to be highly conducive to reducing the mobility of those constituents. For example, it is well-documented that soils with neutral to alkaline pH cause many metals to be strongly retained and reduce the likelihood of a constituent becoming mobile in runoff or as leachate (Bodek, et al., 1988; Dragun, 1988; Lindsay, 1979; Fuller, 1978). The pH for most of the subsurface soils on site was found to range from 6.5 to 8.0; surficial soils ranged from 7.3 to 8.5 (see Appendix 9 of the Revised RFI report). In most cases, the background locations were found to have lower pH values. In addition, oxidizing conditions which are present in surficial soils (and would also be expected for shallow sediments in the drainage ditches) tend to favor attenuation rather than mobilization of metals (Bodek, et al., 1988; Dragun, 1988; Dickson, et al., 1984).

Soil texture (percent sand, silt, and clay) also exhibits a major effect on the mobility of metals present in soils. Texture is related to surface area; in general, the greater the surface area available, the greater the potential for attenuation. It has been demonstrated that, in general, cations (positively charged ions) have low mobility in clay and silty clay soils, and moderate-to-high mobility in loamy and sandy soils (Fuller, 1978; Dragun, 1988). An analysis of a composite of on-site background

TABLE 2-8

**FACTORS WHICH MAY INFLUENCE THE
ATTENUATION OF INORGANICS IN SOIL**

CONSTITUENT PROPERTIES

Speciation
Solubility
Concentration
Valence State(s)
Redox Potential and Eh
Competing Anions and Cations

SOIL PROPERTIES

pH
Soil Texture/Particle Size
Organic Content
Cation Exchange Capacity
Content of Fe, Al and Mn Oxides
Pore Size and Bulk Density
Moisture Content
Salinity

PHYSICAL/ENVIRONMENTAL PROPERTIES

Background Concentrations
Anaerobic/Aerobic and Oxidizing/Reducing Conditions
Climate (Precipitation, Temperature, Wind)
Topography
Erosion Potential/Runoff
Land Use
Vegetation

surficial soils indicates that the surficial site soils are classified as a "clay loam", consisting of 29 percent clay, 45 percent silt, and 26 percent sand (Table 2-9). Independent of other factors, this texture indicates that metals would have low-to-moderate mobility.

Cation exchange capacity (CEC) is another soil property closely related to soil texture which has been shown to have an effect on the mobility of metals in soil. The CEC of a given soil represents the extent to which the clay and humic fractions of the soil will retain charged species such as metal ions. Soils with a high CEC would be expected to retain correspondingly high levels of inorganics. The CEC for the background surficial soil samples was determined to be 10.9 meq/100 g (see Table 2-9); a slightly lower value than would be expected for a soil of clay loam texture (typical range 4 to 32 meq/100 g). This CEC value indicates that metals would be retained more readily than in sandy soils (typical range 2 to 7 meq/100 g) but less than some clays (typical range 5 to 60 meq/100 g; Dragun, 1988).

The organic content of soil is related to soil texture and the CEC, and has been demonstrated to have a significant effect on the ability of soils to reduce metals mobility (Dragun, 1988; Fuller, 1978). Soil organic content has been found to range from 2 percent for many subsurface soils to over 20 percent for a peat soil (USEPA, 1989a). Organic matter for the background surficial soil composite was measured at 11.5 percent, which is high for a clay loam (see Table 2-9). Therefore, all of the physical measurements for the surficial soils typically found at the RMI Sodium Plant indicate that the surficial soils would be expected to be very effective in attenuating the movement of site constituents.

The soil/water partitioning coefficient (K_d) is a parameter often used to describe the sorption potential of both inorganic and organic constituents. K_d can be defined as:

$$K_d = \frac{\text{Concentration of X in soil}}{\text{Concentration of X in water}}$$

K_d is assumed at equilibrium conditions, and is usually expressed in mL/g. Values of K_d incorporate many of the soil and constituent properties described previously; likewise, K_d values are also affected by these factors. K_d values have been shown to be inversely proportional to soil particle size (i.e., the smaller the particle size or

TABLE 2-9
PHYSICAL PROPERTIES OF
BACKGROUND SURFICIAL SOILS^a

Parameter	Value
Cation Exchange Capacity	10.9 meq/100 g
Organic Matter	11.5 percent
Texture	Clay Loam ^b
Sand	26 percent
Silt	45 percent
Clay	29 percent
pH	7.4

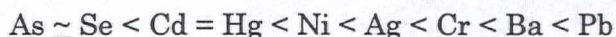
^aComposite of background surficial soils SSB-5, SSB-6, SSB-7, SSB-8, SSB-9, SSB-10, SSB-11, and SSB-12.

^bUsing the USDA classification system.

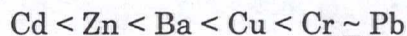
clay content, the higher the K_d) and directly proportional to organic content of the soil (Bodek, et al., 1988; Dragun, 1988).

In general, as previously discussed, cations such as metals are sorbed to soils to a much more significant degree than are hydrophobic organic compounds. For example, for a clay soil with 1 percent organic content, the following K_d values have been calculated for some common industrial solvents: methylene chloride, 0.11; trichloroethylene, 1.3; and chlorobenzene, 2.0 (Clarke, 1987). Much higher K_d values have been calculated for more complex and persistent organics such as pesticides and PCBs.

Table 2-10 shows a range of K_d values obtained from the literature for the inorganic constituents identified in surficial soils at the RMI Sodium Plant, for a variety of soil types. As shown, many of the K_d values for the site constituents are very large, particularly when compared to some organics. Table 2-10 also shows the predicted mobility of the site constituents relative to one another. Based on equilibrium conditions over a wide range of soil types, and recognizing the overlaps in K_d ranges, Table 2-10 indicates the following relative order of increasing sorption or attenuation potential for the site constituents:



Other sources have described the following order of increasing sorption portion for some of the site constituents (US Nuclear Regulatory Commission, 1980):



Although there are some discrepancies in expected behavior because of the complexity of factors affecting sorption potential of the site constituents in surficial soils, for the major waste constituents found at the site (Ba, Cd, Pb), it may be inferred that Cd would be least sorbed, Pb would be most sorbed, and Ba would be intermediately sorbed, relative to Cd and Pb. As discussed in Section 5.3.4 of the Revised RFI report, chemical speciation or the ionic form in which the inorganic site constituents are expected to exist in soils, greatly influences their mobility. Because of the soil properties recently discussed, it appears that the site constituents are most likely strongly sorbed to site soils, and would not be expected to leach into

TABLE 2-10

REPRESENTATIVE SOIL/WATER PARTITIONING COEFFICIENTS (K_d)
FOR A VARIETY OF SOIL TYPES

Constituent	Ranges of K_d (mL/g) in Soil
As	1.0 - 8.3 ^a (As ⁺³); 1.9 - 8 ^a (As ⁺⁵)
Ba	530 - 2,800 ^b (sediments)
Cd	1.3 - 27 ^a ; 1.2 - 2.5 ^b (sediments)
Cr	470 - 150,000 ^a (Cr ⁺³); 1.2 - 1,800 ^a (Cr ⁺⁶)
Pb	4.5 - 7,640 ^a
Hg	10 ^c (Ranges up to 1×10^6 in clays) ^b
Se	1.2 - 8.6 ^a (Se ⁺⁴); 5.91 - 300 ^d
Ag	10 - 1,000 ^a
Ni	0.2 - 200 ^b (clays)

^aDragun (1988).^bBodek, et al. (1988).^cUS Public Health Service (1988a).^dUS Public Health Service (1988b).

groundwater or to become soluble and subsequently be subject to runoff to the site drainage system. This has been substantiated by site measurements of the constituents in groundwater and surface water (see Sections 6.1 and 6.3 of the Revised RFI report). The solubility of the site constituents in surface water will be further discussed in Section 2.3.

2.2.2.2 Mechanisms of Constituent Transport. As mentioned earlier in Section 2.2.2, the only expected migration pathways of site constituents are the potential leaching of soils to shallow groundwater or to site drainage ditches; and the potential erosion of soils into air and/or site drainage ditches. These potential mechanisms of transport will be considered separately, below.

Potential Leaching of Constituents from Soils/Wastes

As discussed in Section 2.1, elevated concentrations of Ba and Cd are present in groundwater beneath the RMI Sodium Plant site, with the highest levels occurring north and east (Areas G and D) of the wastewater treatment ponds, respectively. It is possible that these elevated levels of constituents are due, in part, to the leaching of soils and/or waste materials in those areas.

As discussed in Sections 2.2.1.1 and 2.2.1.2, waste management Areas B, C, F, and G have been shown to have elevated levels of Ba, Cd, Pb, Ni, and As, in surficial soils collectively. In addition, elevated concentrations of Ba, Cd, Pb, and to a lesser extent, Ni, Cr, Ag and Hg have been indicated in some layers of subsurface soils in Areas D and G. However, because there is a general trend for surficial soils in all areas to show a substantial decrease in concentrations between the surficial and the first subsurface soil layers, it is not believed that downward leaching of constituents from surficial soils to shallow groundwater or to site drainage ditches is occurring. In addition, the low concentrations of site constituents detected in the surface water samples taken from the site drainage ditches relative to concentrations in adjacent surficial soils indicate that the leaching of constituents from surficial soils to on-site surface water is not occurring. This assumption has been corroborated by the discussion of attenuation/sorption potential in Section 2.2.2.1 which indicates that the physical and chemical properties of the site constituents and the physical properties of surficial site soils make it highly likely that the metals present will be strongly sorbed to surficial soils on site.

However, because of the high concentrations of some site constituents in subsurface soils, especially in Areas D and G, and because the highest concentrations of Ba and Cd in groundwater were also identified in these areas, the potential downward leaching of constituents in subsurface soils to groundwater appears to be more likely than the leaching of surficial soils.

Also, because of reducing (rather than oxidizing) conditions expected to occur in groundwater, the sorption/attenuation arguments based on physical/chemical properties may not all be applicable to groundwater.

As a means of estimating the relative potential of site constituents to leach from subsurface soils and become mobile in groundwater, the average velocities of the site constituents in the soil/groundwater matrix were determined using retardation factors by (USEPA, 1988b):

$$V_a = \frac{V_s}{R_d}$$

where:

V_a = average velocity of element in soil/groundwater matrix (feet/yr)

V_s = horizontal seepage velocity or hydraulic conductivity (feet/yr)

R_d = retardation factor (unitless); and

$$R_d = 1 + \frac{K_{dpb}}{P}$$

where:

K_d = soil/water partitioning coefficient or sorption constant of element (mL/g)

ρ_b = bulk soil density of soil (g/mL)

P = effective porosity of the soil

In order to calculate the relative velocities of the site constituents in soil, a range of K_d values from the literature for each constituent was used (see Table 2-10). A range of horizontal seepage velocity reported in Sections 4.2.2 and 6.1.1.2 of the Revised RFI report was also used, 0.7 to 7.0 feet per year. A value of 1.50 g/mL was

assumed for bulk soil density which is a representative value for a clay loam (Fuller, 1978). A value of 0.30, which is typical for glacial tills, was assumed for the effective porosity of the soil (Freeze and Cherry, 1979). The average velocities of the site constituents calculated using the method described above are given in Table 2-11.

As shown in Table 2-11, all of the calculated average constituent velocities are considerably lower than the estimated seepage velocity (0.7 to 7.0 feet/year), indicating that the constituents are moving more slowly than the mass flow of groundwater, i.e., the constituents are being attenuated to various degrees in subsurface soils. Table 2-11 indicates that Ni, As, Se and Cd would be the most mobile in groundwater of the constituents evaluated, and that Ba and Cr would be the least mobile. Therefore, it appears that Cd would be more likely to be leached than Ba. However, these comparisons are only relative, because of the range of values assumed, especially for K_d .

A more direct demonstration of the leaching potential of on-site subsurface soils was obtained in the measurements of EP Toxicity of selected soil borings, as described in Section 6.2.2 of the Revised RFI report. All of the soil boring results were compared to an "EP Toxicity equivalent factor", based on the dilutions used in the analytical procedure, to select certain borings for actual EP Toxicity tests. The EP Toxicity equivalent factors, as presented in Table 6-3 of the Revised RFI report, are the maximum contaminant concentrations (the EP Toxicity limits) multiplied by 20. Only two subsurface samples exceeded the EP Toxicity equivalent factors; SB-16 (at 0.5 to 3.3 feet) and SB-17 (at 1.6 to 3.3 feet), for Pb and Cd. Both of these borings were collected in Area G, north of the wastewater treatment ponds. These two samples had the highest individual subsurface concentrations of Ba (1,940 ppm--SB-16); Cd (173 ppm--SB-16); and Pb (315 ppm--SB-17) of all subsurface soils measured.

Table 2-12 shows the results of the EP Toxicity analyses, along with the soil concentrations measured, and the EP Toxicity limits for Cd and Pb (Ba was not analyzed for EP Toxicity because the soil concentrations did not exceed the EP Toxicity equivalent factor). As shown, neither SB-16 nor SB-17 exceeded the EP Toxicity limit for Pb or Cd.

TABLE 2-11

**CALCULATED RANGES OF SITE CONSTITUENT
VELOCITIES IN GROUNDWATER^a**

Constituent	Range of K_d (mL/g) ^b	Retardation Factor (R_d)	Range of Average Constituent Velocity, V_a (ft/yr)
Ba	530 - 2,800	2,651 - 14,000	5.0×10^{-5} - 2.6×10^{-3}
Cd	1.3 - 27	7.5 - 136	5.1×10^{-3} - 0.93
Pb	4.5 - 7,640	23.5 - 38,200	1.8×10^{-5} - 0.30
Ni	0.2 - 200	2 - 1,000	7.0×10^{-4} - 3.5
Cr(+3)	470 - 150,000	2,351 - 750,000	9.0×10^{-7} - 3.0×10^{-3}
Ag	10 - 1,000	51 - 5,000	1.4×10^{-4} - 0.14
Hg	10	51	0.014 - 0.14
Se	1.2 - 300	7 - 1,500	4.7×10^{-4} - 1.0
As(+3)	1.0 - 8.3	6.0 - 42.5	0.016 - 1.2

^aCalculated by method described in text. Seepage velocity range of 0.7 to 7.0 ft/yr assumed (see Section 4.2.2 of the Revised RFI report). Assumed value of 1.5 g/mL for bulk soil density and 0.3 for effective porosity.

^bRanges from literature (see Table 2-10).

TABLE 2-12

**COMPARISON OF SOIL CONCENTRATIONS WITH
EP TOXICITY RESULTS FOR BORINGS SB-16 AND SB-17^a**

Subsurface Soil Sample	Cd Concentration (ppm)			Pb Concentration (ppm)		
	Soil	EP Tox Limit ^b	EP Tox Extract	Soil	EP Tox Limit ^b	EP Tox Extract
SB-16 (0.5 to 3.0 ft)	173	1.0	0.10	195	5.0	BMDL
SB-17 (1.6 to 3.3 ft)	66.1	1.0	0.06	315	5.0	BMDL

^aSB-16 and SB-17 had the highest subsurface soil contaminations measured on site.

^bPer 40 CFR 261.24.

Based on calculations of constituents velocities, it was indicated that Cd might be one of the most mobile constituents in groundwater. However, on the basis of actual leaching tests of subsurface soils with the highest concentrations of Cd, and Pb (and approximations for Ba), none of these constituents appear to be very likely to leach from on-site subsurface soils. Therefore, it seems that the elevated concentrations of Ba and Cd in groundwater, particularly in Areas D and G, may have partially resulted from a release mechanism other than leaching, such as recharge from the wastewater treatment ponds. This potential release mechanism will be further discussed in Section 2.3.1.1.

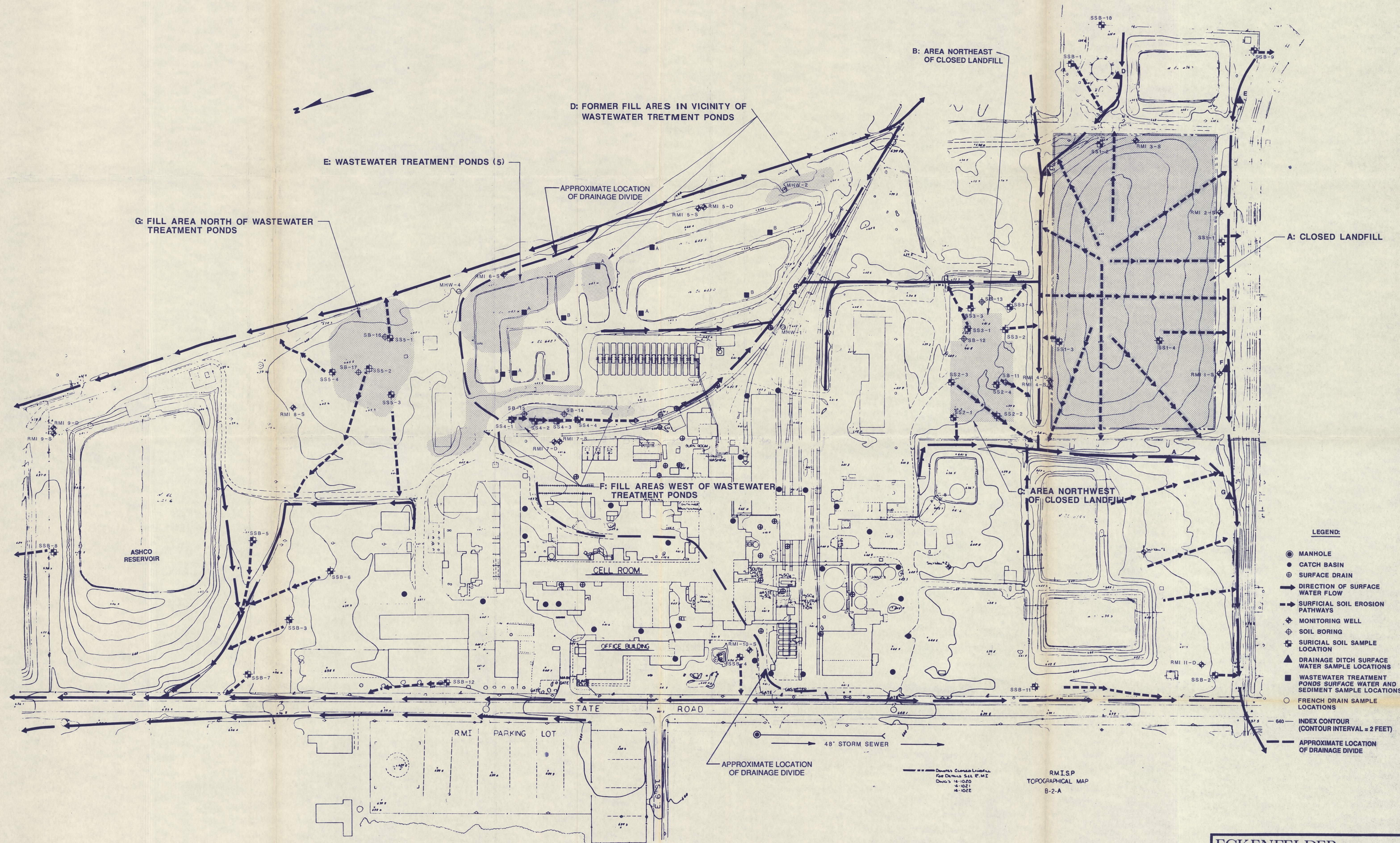
Potential Erosion of Surficial Soils

Expected erosion patterns based on site topography are shown in Figure 2-3. As shown in the figure, the topography of the site is such that surficial soils located at the southern portion of the site would be expected to erode via precipitation, and eventually migrate towards the site drainage ditches to the south and west of the RMI property. Surficial soils located north and west of the wastewater treatment ponds would be expected to primarily migrate via erosion to the northwest, with a small component migrating to the east.

The potential also exists for surficial soil erosion to occur via wind as well as incident precipitation. However, the amount of erosion expected from wind is expected to be less than from precipitation, and would be more localized (i.e., restricted to RMI property). In addition, because site access is restricted and no receptors have been identified in the immediate site vicinity (see Figure 2-1), erosion losses due to wind were not determined to be significant, and thus were not evaluated.

Therefore, because erosion of surficial soils via incident precipitation and the potential for off-site migration of constituents via the DS Tributary is considered to be a primary pathway of concern, it was further evaluated, as described below.

In order to estimate the potential for site constituents to migrate off site due to soil erosion from incident precipitation, the Universal Soil Loss Equation (USLE) was used. This equation enables the prediction of the average rate of soil erosion for



specific soil types, rainfall patterns, topography, and management practices (Wischmeier and Smith, 1978). The soil loss equation is given as:

$$A = R \times K \times L \times S \times C \times P$$

where:

- A = the estimated soil loss, in tons per acre-year
- R = the rainfall and runoff factor
- K = the soil erodibility factor
- L = the slope-length factor
- S = the slope-steepness factor
- C = the cover and management factor
- P = the support practice factor

The rainfall and runoff factor (R) was obtained from the Ashtabula County Soil Conservation Service (Personal Communication, 1989, K. Coy, Soil Conservation Service, Ashtabula County). For all of Ashtabula County, R is equal to 125; therefore, this value was used for all waste management units evaluated.

The soil erodibility factor (K) was determined by calculation using physical soil data obtained from the background surficial soil composite (see Table 2-9). Percent silt, percent sand, percent clay, percent organic matter, soil structure, and permeability class were determined, from which the K value of the soil was calculated using the equation of Wischmeier and Smith (1978):

$$100K = 2.1 M^{1.14} (10^{-4}) (12-a) + 3.25 (b-2) + 2.5 (c-3)$$

where:

- M = particle-size parameter defined as (percent silt) (100 - percent clay)
- a = percent organic matter
- b = soil structure code
- c = profile - permeability class

The background surficial soil composite was found to have an organic content of 11.5 percent (see Table 2-9). When this organic content was used in the calculations, the equation above resulted in a K value of 0.08. For agricultural loads in Ashtabula County, the K values range from 0.28 to 0.43. If median organic content for agricultural lands is used (2 percent), the calculated K value is 0.30. The range of K values used (0.08 to 0.30) produced a range of soil losses, which in turn led to the range of yearly losses of each metal.

The slope-length (L) and slope-steepness (S) factors were determined using the slope length and slope angle of the site, along with the LS equation described by Wischmeier and Smith (1978):

$$LS = (\lambda/72.6)^m (65.41 \sin^2 \theta + 4.56 \sin \theta + 0.065)$$

where:

- λ = slope length in feet
- θ = angle of slope
- m = 0.3, for slopes of 1 to 3 percent

The following LS values were calculated for each of the waste management units evaluated with the USLE: Area B, 0.23; Area C, 0.23; Area F, 0.20; and Area G, 0.25.

The cover and management factor (C) was determined by use of C factors for "idle land" as listed by Wischmeier and Smith (1988). Ground cover was considered, and although the presence of appreciable amounts of coarse soil fragments, gravel, and crushed stone can significantly reduce the value of C and, therefore, soil erosion due to a permanent mulch effect, the amount present has not been quantified, and therefore was not included in the cover and management factor used in this study. A value of 0.20 was assumed for C for all waste management units evaluated.

The support practice factor (P) is used for soil conservation planning on cropland, and is equal to 1.0 for land which no soil erosion control practice is in effect (USEPA, 1988a). Therefore, because no soil conservation activities are known to be practiced at the plant, a value of 1.0 was assumed for the RMI site.

After determination of the parameters described above, the potential soil loss on site via erosion was calculated using the USLE for each site constituent with surficial soil concentrations significantly above background (see Section 2.2.1). Erosion losses for Ag and Hg were not calculated because they were not detected in concentrations significantly greater than background for surficial soils in any waste management unit evaluated (Area A had no surficial soils significantly higher than background; no surficial soils were collected in connection with Area D or E). The amount of constituent expected to be available for transport by this soil loss was determined using the average concentration of each metal found in surficial soils at significant concentrations within each waste management area (see Tables 2-2 through 2-7). Once the soil loss (A) was estimated, it was possible to predict the mass loss of each metal (in pounds/year), for each waste management unit, as shown below:

$$\begin{array}{ccccccc} \text{Mass of Metal} & = & \text{(A) Soil Loss} & \times & \text{Area of} & \times & \text{Average Conc. of} \\ \text{Lost (lb/yr)} & & \text{from Erosion} & & \text{Unit (acres)} & & \text{Metal in Surficial} \\ & & \text{(tons/acre-yr)} & & & & \text{Soil (ppm)} \end{array}$$

Table 2-13 summarizes the estimated yearly loss of each metal of concern due to soil erosion from each waste management area considered, in units of pounds/year. This value was compared with a "background" loss, obtained by multiplying the total soil loss for each area (in tons/acre-year) by the average concentration of each constituent in the background surficial soil samples, times the area of the waste management unit, as described above. Areas for background calculations were assumed to be equal to the areas of the waste management units, respectively, and were calculated from dimensions given in Table 5-2 of the Revised RFI report.

The data in Table 2-13 are given on a per waste management unit basis. On this basis, the highest estimated erosion loss (using the most conservative value, 2 percent organic content) was calculated for Ba (2.19 pounds per year) in Area F. In fact, Area F was found to have higher erosion losses more frequently (four of the seven constituents considered) than all of the other units. In addition to Ba, Area F had the highest calculated erosion loss for Pb (0.604 pounds/year); Ni (0.419 pounds per year); and As (0.121 pounds per year). Area B was found to have the highest calculated erosion loss for Cd (0.0824 pounds per year); Area C was found to have

TABLE 2-13

**ESTIMATED RANGES OF YEARLY EROSION LOSSES FROM
WASTE MANAGEMENT AREAS AND YEARLY BACKGROUND
RANGES OF LOSSES BASED ON THE USLE AND AVERAGE
SURFICIAL SOIL CONCENTRATIONS^a**

Waste Management Area (acres)	Ba	Cd	Pb	Cr	Ni	As	Se
<u>Area B (0.12 acres)^b</u>							
- Ave. Surficial Soil Conc. (ppm)	1,573	199	355	21	301	18.4	0.605
- Est. Loss from Erosion (lb/yr)	0.1737-0.6512	0.0220-0.0824	0.0392-0.1470	Surficial Soil Concentrations Not Significant	0.0332-0.1246	0.0020-0.0076	Surficial Soil Concentrations Not Significant
- Est. Background Erosion Loss (lb/yr)	0.0108-0.0403	0.0005-0.0020	0.0027-0.0103	Over Background	0.0029-0.0108	0.0013-0.0050	Over Background
<u>Area C (0.69 acres)^b</u>							
- Ave. Surficial Soil Conc. (ppm)	595	7.81	80.7	19.9	260	21.7	0.683
- Est. Loss from Erosion (lb/yr)	0.3778-1.42	Surficial Soil Concentrations Not Significant	Surficial Soil Concentrations Not Significant	Surficial Soil Concentrations Not Significant	Surficial Soil Concentrations Not Significant	0.0138-0.0517	0.0004-0.0016
- Est. Background Erosion Loss (lb/yr)	0.0618-0.2319	Over Background	Over Background	Over Background	Over Background	0.0076-0.0286	0.0003-0.0012

TABLE 2-13 (Continued)

ESTIMATED RANGES OF YEARLY EROSION LOSSES FROM
WASTE MANAGEMENT AREAS AND YEARLY BACKGROUND
RANGES OF LOSSES BASED ON THE USLE AND AVERAGE
SURFICIAL SOIL CONCENTRATIONS^a

Waste Management Area (acres)	Ba	Cd	Pb	Cr	Ni	As	Se
<u>Area F (2.3 acres)^b</u>							
- Ave. Surficial Soil Conc. (ppm)	318	3.1	87.5	20.5	60.7	17.6	BMDL
- Est. Loss from Erosion (lb/yr)	0.585-2.19	0.0057-0.0214	0.161-0.604	Surficial Soil Concentrations Not Significant	0.112-0.419	0.0323-0.121	Surficial Soil Concentrations Not Significant
- Est. Background Erosion Loss (lb/yr)	0.1792-0.6721	0.0087-0.0328	0.0458-0.1718	Over Background	0.0480-0.1801	0.0221-0.0828	Over Background
<u>Area G (1.38 acres)^b</u>							
- Ave. Surficial Soil Conc. (ppm)	120	8.07	29.1	18.6	29.9	18.6	0.73
- Est. Loss from Erosion (lb/yr)	0.166-0.621	0.0111-0.0418	Surficial Soil Concentrations Not Significant	0.0257-0.0963	0.0413-0.1547	0.0257-0.0963	Surficial Soil Concentrations Not Significant
- Est. Background Erosion Loss (lb/yr)	0.1344-0.5040	0.0066-0.0246	Over Background	0.0193-0.0725	0.0360-0.1351	0.0166-0.0621	Over Background

^aSee text (Section 2.2.2.2) for explanation of soil loss calculation; USLE = Universal Soil Loss Equation. The same average surficial soil background concentrations were used for each area: Ba = 97.4 ppm; Cd = 4.75 ppm; Pb = 24.9 ppm; Cr = 14.0 ppm; Ni = 26.1 ppm; As = 12.0 ppm; Se = 0.51 ppm (see Table 2-2). Ranges given because of different assumptions for organic content of soil (i.e., low ranges assumed 2 percent, high ranges assumed 11.5 percent).

^bAreas calculated from dimensions given in Table 5-2 of the Revised RFI report. Areas for background assumed to be equal to size of waste management areas, respectively.

the highest calculated erosion loss for Se (0.0016 pounds per year); and Area G was determined to have the highest erosion loss of Cr (0.0963 pounds per year) of the four waste management areas considered.

Based on average surficial soil concentrations alone, it would be reasonable to expect Area B to have the highest overall erosion losses of site constituents. Area B had the highest concentrations of four of seven of the site constituents (Ba, Cd, Pb, Cr) compared to the other waste management units. However, Area B is smaller than the other three units. Compared to Area F, Area B had 20 times less area and five times higher concentration of Ba.

Table 2-14 summarizes the highest erosion losses for each constituent for each unit (in pounds/year) from Table 2-13, but also "normalizes" the data per area of each waste management unit, i.e., the data are presented as estimated pound of constituent lost per acre-year. On this basis, Area B was shown to have the highest predicted erosion losses for four of the seven site constituents: Ba (5.43 pound/acre-year); Cd (0.687 pound/acre-year); Pb (1.23 pound/acre-year); and Ni (1.04 pound/acre-year). Area C was shown to have the highest estimated losses of As (0.075 pound/acre-year) and Se (0.0023 pound/acre-year); and Area G was found to have the highest estimated loss of Cr (0.0698 pound/acre-year).

In summary, the leaching of surficial soils to on-site drainage water ditches or to groundwater is not expected to occur in any significant amounts, based on the observation of attenuation of surficial soil concentrations with depth. This assumption is substantiated by the comparison of surficial to subsurface soil data, and the low concentrations of site constituents measured in the site drainage ditches (to be further discussed in Section 2.3.2). It is also corroborated by the physical and chemical properties of the site constituents and soils discussed in Section 2.2.2.1. Leaching of subsurface soils to groundwater was determined to be possible, especially for Cd, but actual leaching tests (EP Toxicity) performed on the site borings with the highest levels of Cd and Pb indicated that leaching of Cd and Pb was not occurring. Therefore, it appears that the elevated concentrations of Ba and Cd in groundwater, especially near Areas D and G, may be partially due to recharge from the wastewater treatment ponds (discussed further in Section 2.3.2).

TABLE 2-14

HIGHEST ESTIMATED YEARLY EROSION LOSSES
ON A PER UNIT AND PER ACRE BASIS^a

Waste Management Area (acres)	Ba	Cd	Pb	Cr	Ni	As	Se
<u>Area B (0.12 acres)</u>							
- Est. Erosion Loss (lb/yr)	0.6512	0.0824	0.1470	--	0.1246	0.0076	--
- Est. Erosion Loss (lb/acre-yr)	5.43	0.687	1.23	--	1.04	0.063	--
<u>Area C (0.69 acres)</u>							
- Est. Erosion Loss (lb/yr)	1.42	--	--	--	--	0.0517	0.0016
- Est. Erosion Loss (lb/acre-yr)	2.06	--	--	--	--	0.075	0.0023
<u>Area F (2.3 acres)</u>							
- Est. Erosion Loss (lb/yr)	2.19	0.0214	0.604	--	0.419	0.121	--
- Est. Erosion Loss (lb/acre-yr)	0.952	0.0093	0.263	--	0.182	0.053	--
<u>Area G (1.38 acres)</u>							
- Est. Erosion Loss (lb/yr)	0.621	0.0418	--	0.0963	0.1547	0.0963	--
- Est. Erosion Loss (lb/acre-yr)	0.450	0.0303	--	0.0698	0.1121	0.0698	--

^aHighest losses per unit calculated from average surficial soil concentrations and lowest organic content (2 percent) using the USLE, from Table 2-13. Highest losses per acre based on same assumptions, only normalized per area of each unit.

Erosion of elevated levels of site constituents in surficial soils was determined to be a potential migration pathway of concern. Potential erosion losses through incident precipitation were quantified by use of the USLE, measured site values, and various assumptions. Erosion losses via wind may also be possible at the site. However, losses through precipitation were determined to be more significant. Therefore, wind erosion losses were not evaluated. Barium was predicted to erode from the surficial soils in the greatest amount compared to other site constituents. On a per unit basis, Area F was determined to have the highest overall erosion losses for Ba, Pb, Ni, and As. On a per acre basis, Area B was determined to have the highest overall erosion losses for Ba, Cd, Pb and Ni. Therefore, Areas B and F appear to present the greatest erosion concerns for surficial soils at the RMI site.

2.2.3 Potential Receptors .

As discussed in Section 4.6.2 of the Revised RFI report, the RMI Sodium Plant is located in a highly industrialized area of Ashtabula County. About 4 percent of the county is classified as residential, with the major residential areas being located along Lake Erie in the areas of Ashtabula City, Kingsville, and Conneaut City. Within a three mile radius of the RMI Sodium Plant, land use is primarily "unclassified", which includes vacant land (55 percent) and farmland (21 percent - see Table 4-17 of the Revised RFI report). Land use in the vicinity of the RMI Plant is shown in Figure 4-24 of the Revised RFI report.

The locations of the residences nearest the RMI Sodium Plant were shown in Figure 2-1. There were only four residences identified in the immediate vicinity of the RMI Plant: two located on East 6th Street, approximately 1,000 feet west of the RMI plant entrance, or about 2,000 feet west of the majority of the waste management units; one located on Lake Road, approximately 500 feet west of the northwestern RMI property boundary, or about 2,000 feet northwest of the majority of the waste management units; and one located approximately 2,500 feet from the southwestern property boundary, or about 4,000 feet southwest of the majority of the waste management units. The areas east and north of the plant are largely industrial. The areas west and south of Route 11 are primarily residential and commercial.

Access to the RMI plant property is restricted. A chainlink fence surrounds the entire property boundary, and access to the plant is limited to RMI authorized personnel only, by means of 24 hour a day security guards. Therefore, direct contact with surficial soils is not considered to be an exposure pathway of concern.

The Sodium Plant property consists primarily of buildings, process areas, the waste management units, and other unregulated units such as the brine ponds. Although there are some open fields, there are no wooded areas on site which would provide a suitable habitat for most of the mammals, birds, and other wildlife endemic to the area. There may be present on-site rodents, transitory birds and various invertebrate species, but the absence of suitable habitats make the occurrence of significant numbers and varieties of wildlife highly unlikely.

As discussed in Section 4.2.4.2 of the Revised RFI report, there are no federal endangered or threatened species, nor federal lands managed for ecological value within a two mile radius of the RMI Sodium Plant. There are also no existing or proposed state nature preserves or scenic rivers in that portion of Ashtabula County. There is, however, one "ecologically significant" area within a two mile radius of the RMI Plant, Walnut Beach Park, located at the far northwestern boundary of the two mile radius, on Lake Erie (see Figure 2-1). In Walnut Park, there are four threatened species of plants, *Juncus alpinoarticulatus*; *Lathyrus japonica*; *Myriophyllum heteronhyllum*; and *Potamogeton richardsonii*. Two of these species are perennial herbs and two are submersed aquatic plants. Although these species are present within a two mile radius of the RMI Sodium Plant, there are no conceivable migration pathways of site constituents which may affect these species.

The potential migration pathways for constituents in on-site soils were described as leaching of surficial or subsurface soils into shallow groundwater; leaching of surficial soils to site drainage ditches; and potential erosion of surficial soils to air and/or on-site surface water drainage ditches. As discussed previously in Section 2.1.3, there are no expected receptors of shallow groundwater. And, as discussed above, there are no human or environmental receptors of significance in the immediate vicinity of the RMI Sodium Plant. Leaching of surficial soils to site surface water is not considered to be significant. Therefore, the only potential migration pathway of concern is erosion of surficial soils to on-site surface water

ditches, and the potential subsequent transfer of soluble constituents in water or insoluble constituents in ditch sediments to locations downstream via the DS Tributary. The surface water pathway will be further discussed in Section 2.3.

2.2.4 Comparison With Appropriate Criteria

Because no receptors were identified in Section 2.2.3 which may come in contact with surficial soils at the RMI Sodium Plant site, a comparison with human or environmental exposure limit criteria is not appropriate. Instead, as benchmarks for the purposes of evaluating the significance of potential releases, the highest estimated erosion losses of surficial soils from the site via incident precipitation were compared to other pollutant criteria established by the USEPA which were generated by the Agency as protective of human health, welfare, and the environment.

One such set of criteria which may be used for a benchmark comparison are the cumulative pollutant loading rates proposed for regulating the land disposal of municipal sewage sludge. The standards were proposed in the *Federal Register* on February 6, 1989 (FR 54(23): 5746 - 5902). The standards appear in 40 CFR 503, and amend previous guidance issued in 40 CFR 257. The USEPA has proposed these regulations to protect public health and the environment from any reasonably anticipated adverse effects of certain constituents which may be present in sewage sludge generated by publicly or privately owned treatment works, or any person who uses or disposes of sewage sludge from such treatment works. The regulations establish requirements for the final use and disposal of sewage sludge when it is applied to land, distributed and marketed, placed in monofills, on surface disposal sites, or is incinerated. The criteria chosen for comparison were the annual cumulative pollutant loading rates for the land application of sewage sludge to agricultural or non-agricultural land.

Table 2-15 summarizes the highest estimated erosion losses from site surficial soils (see Tables 2-13 and 2-14) for each of the constituents where average surficial soils concentrations were significant over background concentrations, and the proposed sewage sludge disposal loading rates for those constituents. As shown in Table 2-15, none of the highest estimated erosion losses exceed the proposed sewage sludge loading rates for these constituents (except Ba, for which no rate has been

TABLE 2-15

**COMPARISON OF HIGHEST ESTMATED EROSION LOSSES FROM SITE
SURFICIAL SOILS WITH REGULATORY CRITERIA**

Constituent	Highest Estimated Erosion Loss		Proposed Sewage Sludge Disposal Cumulative Pollutant Loading Rates ^a	
	(lb/yr)	(lb/acre-yr)	(kg/hectare-yr)	(lb/acre-yr)
Ba	2.19 ^b	5.43 ^c	None Established	None Established
Cd	0.0824 ^c	0.687 ^c	18	16.1
Pb	0.604 ^b	1.23 ^c	125	112
Cr	0.0963 ^d	0.0698 ^d	530	473
Ni	0.419 ^b	1.04 ^c	78	70
As	0.121 ^b	0.075 ^e	14	12.5
Se	0.0016 ^e	0.0023 ^e	32	29

^aProposed rule, 40 CFR 503, "Standards for the Disposal of Sewage Sludge", (*Federal Register*, February 6, 1989).

^bMeasured or calculated from Area F.

^cMeasured or calculated from Area B.

^dMeasured or calculated from Area G.

^eMeasured or calculated from Area C.

established). In fact, the estimated erosion rates are far below these proposed loading rates. Therefore, based on the most conservative erosion estimates for the site and Agency-generated release criteria which were established to be protective of human health and the environment, it appears that none of the surficial soils on site present a potential concern, with regard to erosion. However, as stated in their September 24, 1991 comments on the revised CMS plan, the USEPA notes that this comparison does not have any regulatory significance for RCRA corrective action decisions.

2.2.5 Assessment of Potential for Exposure

As stated in Section 2.2.2, the only potential migration pathways of site constituents in soils to other media were determined to be: leaching of soils to shallow groundwater or to site drainage ditches; and potential erosion to soils to air and/or on-site surface water drainage ditches. Leaching of surficial soils to on-site drainage water ditches or to groundwater is not expected to occur, based on evidence of attenuation of the site constituents with depth, i.e., there is no evident "gradient" of concentrations of constituents with increasing soil depth. This is substantiated by the low concentrations of site constituents in water samples taken from the drainage ditches (see Section 2.3), and the comparison of surficial to subsurface soil concentrations (see Tables 2-2 through 2-6). These observations were corroborated by the evidence presented that the site constituents are likely to be sorbed to a significant degree, based on the physical and chemical properties of the constituents (e.g., K_d values), and of the site soils (e.g., organic content, CEC).

Although subsurface soils at some depths in Areas D and G were shown to be present in concentrations above background levels, because of the distribution of concentrations, it is not believed that leaching of constituents from subsurface soils to shallow groundwater is a significant release mechanism. By the use of retardation factors, it was shown that Cd might be expected to become the most mobile of site constituents in groundwater, but actual leaching tests (EP Toxicity) performed on two subsurface soil borings with the highest concentrations of Ba, Cd and Pb of all site borings showed that Cd and Pb were not leached from the soils (Ba was also estimated not to leach). That significant leaching of subsurface soils to groundwater is not likely to occur has been also substantiated by the discussion of the likelihood of the inorganic site constituents being strongly sorbed to on-site

soils, based on the chemical properties of the constituents and on the physical measurements of the on-site soils, although all of these arguments may not be as applicable to groundwater because of expected reducing conditions. Because leaching of subsurface soils to shallow groundwater is not likely to occur, it is assumed that elevated groundwater concentrations of Ba and Cd may be due, in part, to leakage from the wastewater treatment ponds in the Areas of D and G (discussed further in Section 2.3).

The only potential exposures from these release mechanisms discussed above would be via either contact with groundwater off site, or contact with surface water in the DS Tributary off site which may have been impacted by these potential releases associated with site soils. However, because these mechanisms were shown to be unlikely to occur, and there were no shallow groundwater receptors identified (see Section 2.1.3), these potential mechanisms are not expected to result in exposure to human or environmental receptors. The surface water pathway will be further discussed in Section 2.3.

Erosion of surficial soils by wind into the air was not considered to be a significant release pathway because no receptors were identified and the effects would be highly localized; therefore this pathway was not evaluated. Erosion of surficial soils via incident precipitation and possible subsequent migration off site through site surface water ditches, however, was determined to be a potential pathway of concern. Areas B and C, F, and G were shown to have surficial soil concentrations significant over background levels for some constituents. On a per unit basis, it appeared that Area F may present the greatest concern for the loss of surficial soils through erosion. However, on a per area basis, Area B was shown to present a greater potential concern for erosion losses than the other units evaluated. In comparing the highest estimated erosion losses with Agency-generated criteria which were established to be protective of human health, none of the losses appeared to present a potential concern.

2.3 SURFACE WATER PATHWAY

2.3.1 Potential Sources and Concentrations

As described previously in Section 5.2.2 and 6.3 of the Revised RFI report, surface water at the RMI Sodium Plant exists in two forms: the five wastewater treatment ponds (Area E); and the shallow drainage ditches which are found around the plant, particularly on the south end of the property. A number of catch basins and surface drains are also present, primarily in the process and wastewater treatment pond areas to intercept surface water flow (see Figure 2-3). These basins and drains are routed through a storm sewer system, also utilized by other industries along State Road, which discharges directly to Fields Brook via an NPDES-permitted outfall. The only connection between the wastewater treatment ponds and the on-site surface water drainage system is believed to be the possible recharge of groundwater in the vicinity of the ponds (from pond leakage/leachate) and subsequent discharge of a portion of the groundwater to the site drainage system. Therefore, consistent with previous sections of this report, the ponds and the site drainage system will be considered separately in this section.

2.3.1.1 Wastewater Treatment Ponds. As discussed in Section 5.2.2.1 of the Revised RFI report, the wastewater treatment ponds are used primarily as sedimentation basins for various plant wastestream influents. Water is discharged from the plant to Ponds 1 and 2 and is ultimately discharged from Pond 5 to Fields Brook via an NPDES-permitted outfall. A french drain exists around the perimeter of the ponds for the purpose of collecting leakage or leachate emanating from the ponds. Pumps return collected liquids to the pond system, and the ponds are periodically dredged for sludge removal. EP Toxicity results have indicated that the pond sludge is not a hazardous waste (see Appendix 8 of the Revised RFI report).

During the RFI, samples were collected from the wastewater treatment ponds (water and sediments) and from the french drain to evaluate the levels of constituents present. As shown previously in Table 6-6 of the Revised RFI report, Ba and Cd were present in all pond water samples, with only Ba found in appreciable concentrations, ranging from 770 ppb in Pond 2 to 5,500 ppb in Pond 3. Chromium was detected in lower concentrations (maximum 59.8 ppb) in Pond 1, 2, and 5 only. As was shown in Table 6-7 of the Revised RFI report, only Ba, Cr, and

Pb were consistently detected in pond sediments; Ag was also found in trace amounts in four of the five ponds. Barium was the only constituent in appreciable concentrations in the pond sediments, ranging from 31.5 ppm in Pond 2 to 3,020 ppm in Pond 4. Chromium was also found in lower concentrations in pond sediments, at a maximum of 17.5 ppm in Pond 1.

Water samples were also collected at four manholes associated with the french drain system. The concentrations of the manhole water samples were substantially lower than the pond water concentrations (see Table 6-8 of the Revised RFI report). The highest concentration was measured for Cd from the manhole located west of Pond 5, at 26.8 ppb. The french drain is situated such that both water from the wastewater ponds and shallow groundwater is collected.

As mentioned above and in Section 5.2.2.1 of the Revised RFI report, effluent from the pond system is discharged to Fields Brook through an NPDES-permitted outfall. Under the NPDES permit, weekly monitoring for flow, BOD₅, TDS, TSS, TRC, and temperature is performed. The outfall effluent has been measured for priority pollutants on at least two occasions: once by the USEPA as a part of the Fields Brook Remedial Investigation in 1983 and 1984 (USEPA, 1985a), (see Table 4-7 of the Revised RFI report) and once in September 1988 in connection with acute toxicity tests performed for RMI by ECKENFELDER INC.® (see Appendix 8 of the Revised RFI report). Organics were not found in either analysis of the plant effluent. The results of analyses for the inorganic parameters of interest are summarized in Table 2-16. A comparison of the two analyses is inconclusive, however. Most of the detectable concentrations for the USEPA analyses are questionable, and several of the inorganic constituents of interest were not analyzed in the September 1988 sample. However, in comparing the September 1988 analysis with the Pond 5 sample (see Table 6-5 of the Revised RFI report), neither Cr or Cd were detected in the September 1988 analysis, but were detected in the Pond 5 water sample taken during the RFI.

In August 1988, acute (48 hour) toxicity tests were performed on the final effluent from the RMI plant. The tests were conducted using fathead minnows (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*). There were no acute mortalities from the effluent tested with the fathead minnows, and a 45 percent mortality in the water flea test. No LC50 values were calculated since a 50 percent mortality

TABLE 2-16
RESULTS OF ANALYSES OF WATER FROM
THE RMI SODIUM PLANT NPDES OUTFALL^a

Constituent	September 1988 Analysis (ppb)	USEPA 1983-84 Analysis (ppb)
As	BMDL	No Data ^b
Ba	Not Analyzed	600
Cd	BMDL	BMDL
Cr	BMDL	BMDL
Pb	BMDL	BMDL
Hg	Not Analyzed	0.4 ^b
Ni	BMDL	BMDL
Se	Not Analyzed	No Data ^b
Ag	Not Analyzed	BMDL
Zn	BMDL	23 ^b
Sodium	104	No Data
Chloride	164	No Data

^aPriority pollutant scans performed, but no organics detected in either analysis. September 1988 analysis performed by ECKENFELDER INC.; 1983-84 analysis performed by USEPA (1985a) during the Fields Brook Remedial Investigation (see data in Table 4-7 and Appendix 8 of the Revised RFI report).

^bQuality of data noted as questionable by USEPA.

was not observed in either test (see Appendix 8 of the Revised RFI report). The 50 percent mortality rate is recognized as a significant adverse effect level in acute toxicity tests. In general, invertebrates (such as *Ceriodaphnia*) are more sensitive to inorganic concentrations than are fish, therefore the difference in results for the fatheads and *Ceriodaphnia* is not unusual. *Ceriodaphnia* are especially more sensitive to TDS (e.g., including Na and Cl) than are fatheads (USEPA, 1988d).

Therefore, it is possible that the mortality experienced by the *Ceriodaphnia* was due to the levels of Na and Cl in the effluent, or possibly trace concentrations of constituents such as Ba, Hg, Se, or Ag which were not measured in the effluent at the time.

2.3.1.2 Drainage Ditch Systems. As discussed in Sections 4.4.2 and 6.3.2 of the Revised RFI report, a drainage ditch system exists on the RMI Sodium Plant property for the purpose of conveying stormwater runoff from the RMI property. In addition, it is believed that the on-site ditch system intercepts a portion of the shallow groundwater beneath the RMI property. The on-site surface water drainages were shown in Figure 4-23 of the Revised RFI report, and are also indicated on Figure 2-3. The figures indicate that there is generally a drainage divide within the main process area of the plant site. Water falling south of the divide is expected to be intercepted by ditches which flow to the west and south; the southwestern part of this ditch system is known as the DS Tributary of Fields Brook. Prior to closure of the landfill (Area A), the DS Tributary flowed across the area currently occupied by the closed landfill. During closure of the landfill in 1981, the DS Tributary was rerouted such that it flows from east to southwest, along the northern edge of the closed landfill. The DS Tributary joins a drainage ditch flowing from east to west on the southern edge of the closed landfill between the RMI plant and the neighboring Detrex facility, and then flows southwesterly, under State Road, to Fields Brook. The drainage area located on the southern edge of the closed landfill is believed to originate off site to the east, near the abandoned pond. Water falling north of the divide is expected to flow to the north of the site, and ultimately to Lake Erie.

Water samples were collected from seven on-site locations (samples DW-A through DW-G) in the drainage system on the southern portion of the RMI property in February 1989 during the RFI (see Figure 2-3). Ditch sample location DW-E,

located at the southeastern corner of the RMI property and ditch sample location DW-G, located at the southwestern property boundary, were chosen, in part, because they represent areas on the RMI property where segments of the drainage ditch flow onto and off RMI property along the southern border, respectively. In addition to metals analyses, priority pollutant scans were performed on samples DW-E and DW-G to evaluate the presence of organic constituents believed to be migrating onto RMI property from off site.

The ditch water sample results were presented in Table 6-9 and discussed in Section 6.3.2 of the Revised RFI report. Table 2-17 is a summary of the inorganic results for the drainage ditch water samples. Barium, Cd, and Pb were analyzed in all on-site ditch water samples, and additional metals were analyzed in samples DW-E and DW-G. Collectively, As, Cd, Pb, and Zn were detected in the on-site ditch water samples. Barium was BMDL in all samples analyzed; Cd was detected in four of the seven samples, ranging from 1.9 ppb in DW-A to a maximum concentration of 37.9 ppb detected in DW-B; and Pb was detected in five of the seven samples, with a maximum concentration of 4.9 ppb in Sample DW-E. Neither Ba, Cd, or Pb were detected in DW-C. Zinc was detected at relatively high concentrations in DW-E (359 ppb) and DW-G (77 ppb). Sample DW-D was considered to be a background sample, as it appears to be removed from the influence of RMI Plant activities. Relative to sample DW-D, it appears that only the Cd concentration in DW-B and the Zn concentrations in DW-E and DW-G may present a potential for concern.

The presence of Zn in sample DW-E suggests contribution from an off-site source, which is supported by the location of DW-E. Although Zn has been detected in subsurface soil borings for wells 1-S and 2-S collected in the vicinity of the closed landfill (see Appendix 9 of the Revised RFI report), the location of DW-E is upstream and upgradient of the closed landfill and represents the point where water flows onto RMI property from off site. The decrease in concentration of Zn from location DW-E to DW-G (from 359 to 77 ppb) may be due to dilution and/or the sorption of Zn to ditch sediments.

The relatively high Cd concentration at only one on-site ditch location, DW-B, suggests contribution from a localized source. Ditch sample DW-B is the closest ditch sample to Area B, the fill area northeast of the closed landfill. As was

TABLE 2-17

SUMMARY OF INORGANIC ANALYTICAL RESULTS FROM RMI
ON SITE DRAINAGE DITCH SURFACE WATER SAMPLES^a
FEBRUARY 1989

Constituent	Detection Limit (ppb)	Total Concentration (ppb)							
		DW A	DW B	DW C	DW D	DW E	DW F	DW G	DW H
As	1.0	NA ^b	NA	NA	NA	BMDL ^c	NA	1.8	NA
Ba	500	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Cd	1.0	1.9	37.9	BMDL	BMDL	BMDL	3.1	2.1	BMDL
Cr	5.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA
Pb	2.0	3.7	BMDL	BMDL	3.6	4.9	3.8	3.6	BMDL
Hg	0.4	NA	NA	NA	NA	BMDL	NA	BMDL	NA
Ni	100	NA	NA	NA	NA	BMDL	NA	BMDL	NA
Se	1.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA
Ag	1.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA
Zn	10	NA	NA	NA	NA	359	NA	77	NA
pH (units)	--	6.56	7.16	7.50	7.35	6.27	6.97	6.51	7.93
Hardness (mg/L as CaCO ₃) ^d	--	283	1,144	153	135	1,030	1,456	317	BMDL

^aSee Table 6-9 of the Revised RFI report.

^bNA = Not analyzed.

^cBMDL = Below method detection limit.

^dHardness calculated from Ca and Mg concentrations (see Appendix 9 of the Revised RFI report) from *Standard Methods*, No. 314A (AWWA, 1985).

^eField blank.

discussed previously in Section 2.2.2.2, the highest single measurement (731 ppm) and highest average (199 ppm) concentration of Cd measured in surficial soils on site was found at Area B. In addition, the highest estimated erosion loss of Cd from the waste management areas evaluated was calculated for Area B, both on a per unit and per area (acres) basis. Therefore, because of the erosion patterns of surficial soils at Area B (see Figure 2-3), and because of the proximity of ditch sample DW-B to Area B, it appears likely that the relatively high concentrations of Cd in the DW-B water sample is due to erosion of surficial soils from Area B.

Two off-site surface water samples (SW-3 and SW-4) were collected from the drainage ditch located along the eastern boundary of the plant site in February 1991 during the Supplemental Investigation (see Figure 1-1). The off-site ditch water samples were analyzed for As, Ba, Cd, Cr, Cu, Hg, Pb, Ni, Se, Ag, Zn, and cyanide. Sample results were discussed in Section 4.3.2 of the Revised Supplemental Investigation report and are summarized in Table 2-18. Off-site ditch water samples were not filtered and water concentrations are reported as totals (dissolved plus suspended). Detectable concentrations of inorganics measured in the off-site ditch water samples were present at relatively low levels. Cyanide, Se, and Ag were not detected in either of the off-site ditch water samples. As, Ba, Cu, and Zn were detected only in sample SW-3, at relatively low concentrations ranging from 5.1 ppb (As, detection limit 5.0 ppb) to 510 ppb (Ba, detection limit 200 ppb). A trace amount of Hg was measured in sample SW-4 (0.26 ppb), which was only slightly higher than the detection limit of 0.20 ppb. Low levels of Cd, Cr, Pb, and Ni were detected in both off-site ditch water samples and were also detected in the field blank at similar levels, with the exception of Ni in SW-3 (38.2 ppb), which was elevated compared to the field blank value (2.3 ppb). As discussed in Section 4.3.2 of the Revised Supplemental Investigation report, the source of water in the eastern drainage ditch is likely to be a leaking or broken pipe from the Ashco Reservoir and the ditch water quality is indicative of water quality in the Ashco Reservoir.

Four sediment samples were also collected during the Supplemental Investigation: two on site (SD-1 and SD-2) in the vicinity of on-site ditch water sample DW-B collected during the RFI, and two off site (SD-3 and SD-4) from the eastern drainage ditch at the locations of SW-3 and SW-4 (see Figure 1-1).

TABLE 2-18

SURFACE WATER AND SEDIMENT
ANALYTICAL SUMMARY

SUPPLEMENTAL INVESTIGATION
FEBRUARY 1991

	Sediment Detection Limits (mg/kg)	Surface Water Detection Limits (ug/L)	Sediment				Surface Water			Field Blank (ug/L)
			SD-1 ^a (mg/kg)	SD-2 ^a (mg/kg)	SD-3 ^b (mg/kg)	SD-4 ^b (mg/kg)	SW-3 ^b (ug/L)	SW-4 ^b (ug/L)	SW-3 ^{b,c} (ug/L)	
Arsenic	0.25	5.0	8.8	21.9	14.8	18.7	5.3	BMDL	5.1	BMDL
Barium	10.0	200	3,590	3,220	121	846	460	BMDL	510	BMDL
Cadmium	0.50	0.10	51.8	35.7	BMDL	32.5	1.2	0.54	0.51	1.4
Chromium	2.5	2.0	15.5	30.1	7.4	38.4	6.3	3.7	8.4	4.5
Copper	1.0	20.0	45.9	95.9	22.2	128	30.0	BMDL	30.0	BMDL
Lead	5.0	3.0	50.0	91.8	26.8	83.5	9.3	3.7	9.3	3.6
Mercury	0.20	0.20	0.49	BMDL	BMDL	0.43	BMDL	0.26	BMDL	BMDL
Nickel	2.0	2.0	72.2	70.4	BMDL	86.8	38.2	2.8	22.7	2.3
Selenium	0.25	5.0	BMDL	BMDL	0.89	BMDL	BMDL	BMDL	BMDL	BMDL
Silver	1.0	20.0	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Total Cyanide	1.0	20.0	2.2	6.1	BMDL ^d	BMDL	BMDL	BMDL	BMDL	BMDL
Zinc	0.75	15.0	276	390	19.5	371	65	BMDL	54	BMDL

^aSamples collected on site in the vicinity of sample DW-B collected during the RFI.

^bSamples collected off site from drainage ditch located along the eastern property line.

^cDuplicate sample.

^dBMDL = Below method detection limit.